Nuclear power and the clean energy transition

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Introduction to nuclear power

Nuclear power harnesses the energy released from atomic reactions to generate electricity. There are two primary types of nuclear reactions used for power: fission and fusion.

Nuclear power is experiencing a resurgence due to the urgent need for clean, reliable energy sources to combat climate change. Modern advancements in nuclear fission technology have led to the development of safer, more efficient reactors, such as small modular reactors (SMRs) and advanced Generation IV designs.

Nuclear fission

Nuclear fission involves splitting the nucleus of heavy atoms like uranium or plutonium, releasing a significant amount of energy. This process is currently utilized in nuclear reactors worldwide.

Nuclear fusion

Nuclear fusion, on the other hand, involves combining light atomic nuclei, such as hydrogen isotopes, to form a heavier nucleus, releasing even more energy than fission. Fusion holds great promise but it remains largely experimental with ongoing research striving to make it a viable energy source.

Nuclear power risks and issues

Despite its potential, nuclear power comes with significant risks and issues.

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Nuclear fission reactors generate radioactive waste, some of which may remain hazardous for thousands of years. Safe and secure long-term storage solutions are challenging and controversial, with concerns about potential leaks and environmental contamination.	Nuclear power plants are expensive to build and decommission, often requiring substantial government subsidies.	The risk of nuclear accidents, although low, can have catastrophic consequences. Prior accident events highlighted vulnerabilities in reactor designs, operational procedures, and emergency response measures. Enhanced safety protocols and newer reactor designs aim to mitigate these risks, but public apprehension remains.	Nuclear fusion technology is still in the experimental stage, requiring extremely high temperatures and sophisticated containment systems to sustain reactions. Achieving net-positive energy output is a formidable hurdle, and the timeline for commercial fusion power remains uncertain. Moreover, the high costs of research and development, along with technical complexities, pose significant barriers.	Both fission and fusion also face regulatory and political hurdles. Nuclear projects often encounter public opposition due to safety concerns, environmental impacts, and potential misuse of nuclear materials.

Advantages of nuclear power

Ability to produce a large amount of electricity with minimal greenhouse gas emissions, helping to combat climate change.

Nuclear fission reactors are highly efficient, capable of generating substantial amounts of continuous, reliable energy. This reliability is crucial for providing baseload power, ensuring a stable electricity supply.

Additionally, advances in reactor technology offer improved safety, flexibility, and cost-effectiveness, making nuclear power more accessible and adaptable to varying energy needs.

Fusion reactions produce significantly more energy than fission with abundant fuel sources, such as isotopes of hydrogen found in seawater. Fusion also generates minimal long-lived radioactive waste and carries a lower risk of catastrophic accidents, as the reactions can be quickly halted if containment is lost.

Contributes to energy security by diversifying energy sources and reducing dependence on imported fossil fuels helping stabilize energy prices and enhance national security.

In the U.S. alone, nuclear electricity prevents more than 471 million metric tons of carbon dioxide from entering our atmosphere every year. Nuclear facilities also require the least amount of land to generate electricity, compared to other energy sources.

https://www.nei.org/advantages/sustainable-development

In 2020, Pennsylvania's nuclear power plants prevented more than 46 million metric tons of carbon emissions which is the equivalent of taking nearly 10 million cars off the road. The saved social cost of carbon is more than $2.4 billion annually, according to the federal government's evaluation.

https://www.nei.org/advantages/climate

Nuclear energy provides nearly 95 percent of New Jersey's clean energy. If New Jersey were to lose its nuclear energy, its clean energy shortfall would be equal to the power used by 3.4 million homes—nearly all of the homes in the state.

https://www.nei.org/advantages/climate

Nuclear Power and the Clean Energy Transition

Nuclear power is crucial for the global **transition to a low-carbon economy** and achieving climate goals. Unlike fossil fuels, nuclear reactors produce electricity with almost no carbon dioxide emissions, making them a key player in decarbonization strategies.

Moreover, advanced nuclear technologies **can be deployed faster and more cost-effectively,** facilitating a quicker transition to a low-carbon energy system. Additionally, ongoing research in nuclear fusion promises a future of virtually limitless, clean energy, further supporting long-term decarbonization efforts.

By providing **a stable and dependable power supply** (unlike solar and wind which are intermittent by nature), nuclear energy complements renewables and enhances the resilience and reliability of the overall energy grid.

Nuclear power also contributes to **energy security and economic stability** by reducing reliance on imported fossil fuels and mitigating the impact of volatile energy markets.

An example of nuclear power innovation: Small Modular Reactors (SMRs)

Small Modular Reactors (SMRs) represent a significant advancement in nuclear technology, offering a more flexible, cost-effective approach to nuclear power. Unlike traditional large-scale reactors, SMRs are designed to be factory-built and assembled on-site, reducing construction times and costs. This modular approach allows for incremental investment and scaling, making nuclear power more accessible to a broader range of markets, including regions with smaller grids or remote locations.

SMRs offer enhanced benefits

- Passive cooling systems that operate without human intervention or external power sources increasing public and regulatory confidence.
- Avoid the stringent and expensive licensing requirements typically associated with large nuclear plants.
- Smaller size and lower upfront capital costs lower financial risk, making them attractive to private investors and utility companies.
- Can be used in a variety of applications beyond electricity generation (e.g., district heating, desalination, hydrogen production)

The financing of Small Modular Reactors (SMRs) involves a combination of public and private funding sources

- Governments play a critical role by providing substantial financial support through grants, subsidies, and loan guarantees designed to encourage research, development, and deployment of SMRs, recognizing their potential to enhance energy security and support decarbonization efforts.
- Private investment is also a key driver in the commercialization of SMRs. Venture capital firms, private equity funds, and energy companies are increasingly investing in SMR projects due to their promising economic and environmental benefits.
- Public-private partnerships are instrumental in advancing SMR technology. Collaborations between government agencies, research institutions, and private companies foster innovation and reduce financial risks. International cooperation and funding from multinational organizations further support the global development of SMRs.
- Utility companies are another important funding source, as they seek to diversify their energy portfolios and meet regulatory requirements for reducing carbon emissions. By investing in SMRs, utilities can secure a stable and reliable source of low-carbon electricity.

AI Data Centers and Nuclear Power

The burgeoning field of AI data centers presents a unique intersection of advanced technology and energy requirements, where nuclear power, particularly from Small Modular Reactors (SMRs), could play a pivotal role. AI data centers demand vast amounts of electricity to power servers and cooling systems, often leading to significant carbon footprints.

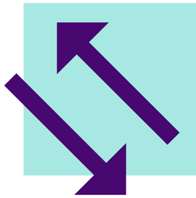
Integrating nuclear power into these facilities offers a solution that aligns with both sustainability goals and the need for reliable, high-density energy sources.

- Consistent and substantial energy supply, crucial for the uninterrupted operation of data centers.
- Unlike renewable sources such as solar and wind, nuclear energy is not dependent on weather conditions, ensuring stable power availability. This reliability is essential for AI operations, which require continuous data processing and storage.

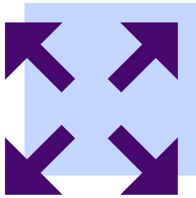
The viability of using SMRs for powering AI data centers lies in their modularity and scalability.

- Factory-fabricated and transported to the site, significantly reducing construction time and costs compared to traditional large-scale reactors.
- Smaller footprint and enhanced safety features make them suitable for locations closer to urban areas, where many data centers are situated.
- The potential for co-generation, where SMRs provide both electricity and heat, can improve overall efficiency and further reduce operational costs.

The construction and constructability of nuclear-powered AI data centers involve key steps.



1. Site selection and regulatory approvals are paramount, requiring thorough environmental and safety assessments.



2. Parallel construction processes manufacturing reactor components off-site while preparing the data center infrastructure on-site.

Why WTW and our expertise?

As one of the world's leading risk advisory and brokerage firms, WTW is uniquely positioned to play a critical role in the reemergence of nuclear power, including the development and deployment of nuclear-powered AI data centers. Here's how WTW can contribute:

Risk Assessment and Management

Extensive expertise in risk assessment to evaluate the potential risks associated with constructing and operating fission and fusion powered facilities, including nuclear-powered AI data centers. This includes analyzing technical, environmental, and regulatory risks. By identifying and mitigating these risks early, WTW can help ensure the project's viability and safety.

Insurance Solutions

Design bespoke insurance products that cover a range of risks, from construction-related liabilities to operational hazards and potential nuclear incidents. These insurance solutions can provide financial protection and reassurance to stakeholders and investors.

Regulatory Compliance and Advocacy

Expertise in regulatory compliance can assist clients in meeting the stringent requirements for nuclear energy and data center operations. Additionally, WTW can advocate for regulatory frameworks that support innovation while ensuring safety and environmental standards.

Construction Project Management

Construction-focused practice can offer project management services to oversee the construction of nuclear-powered facilities and AI data centers. This includes coordinating between various stakeholders, ensuring adherence to timelines and budgets, and implementing best practices in construction safety and quality control.

Financial and Strategic Advisory

Can provide strategic advisory services to help clients develop robust business models for nuclear-powered facilities and AI data centers. This includes financial modeling, cost-benefit analysis, and identifying funding opportunities through public-private partnerships.

Cybersecurity and Operational Resilience

Cybersecurity is paramount. WTW can offer specialized services to enhance the cybersecurity posture of these facilities, ensuring they are protected against cyber threats. Additionally, WTW can help design resilience strategies to maintain continuous operation and recover quickly from disruptions.

Stakeholder Engagement and Communication

Effective communication with stakeholders, including local communities, regulatory bodies, and investors, is crucial for the success of nuclear-powered projects. WTW can develop and implement comprehensive stakeholder engagement plans, ensuring transparency and building trust throughout the project lifecycle.

Overall, by leveraging its multidisciplinary expertise, WTW can support the safe, efficient, and successful realization of the Clean Energy transition, whilst also helping to drive innovation and sustainability in the construction, energy, and technology sectors.

For more information please contact:

Gary Rodrigues
Nuclear Leader, Global Construction
Gary.Rodrigues@wtwco.com

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